

THE
JOURNAL OF ECONOMIC BIOLOGY

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THE
JOURNAL OF ECONOMIC BIOLOGY.

NOTES ON SOME NEW AND RARE THYSANOPTERA
(TEREBRANTIA), WITH A PRELIMINARY LIST OF
THE KNOWN BRITISH SPECIES.

By

RICHARD S. BAGNALL, F.L.S., F.E.S., Etc.

SINCE my last contribution to this Journal (1909, vol. iv, No. 2), I have recorded¹ *Cryptothrips latus*, Uzel, *Trichothrips longisetis*, Bagnall, *T. propinquus*, Bagnall, *Acanthothrips nodicornis* (Reuter), and *Liothrips hradacensis*, Uzel, from the British Isles, whilst in the following pages *Frankliniella breviceps*, sp. nov., *Euthrips pallipennis*, Uzel, *Amblythrips ericae*, gen. et sp. nov., *Oxythrips brevistylis* (Trybom), *O. brevicollis*, sp. nov., *Thrips validus*, Uzel, *T. albopilosus*, Uzel, *Bagnallia agnessae*, sp. nov., and *B. halidayi*, sp. nov., are for the first time recorded as British.

At the end a list of the 74 species now recognized as belonging to our fauna will be found, those marked with an asterisk having been recorded since Haliday's papers were published, and with but one exception during the past three years. A hundred species are known from Bohemia, and I feel confident that as many or more will be found in this country, if diligently and systematically worked.

Prof. O. M. Reuter, in his monograph of the Finnish Thysanoptera, recognizes 59 species, but since that date other forms have been discovered, so that the list includes more than 60 species. In Dr. Buffa's last note on Italian Thysanoptera he gives a list of 42 species. With the exception of the Scandinavian countries and Belgium, and of course those referred to above, very few thrips indeed are recorded from the European countries.²

¹Entom. Mon. Mag., Nov., 1910, and Trans. Nat. Hist. Soc. of Northumberland, Durham, and Newcastle-on-Tyne, December, 1910.

²Dr. Trybom has added considerably to our knowledge of the Swedish Thysanoptera, whilst I hope to publish notes shortly on collections recently made by myself in Norway, Denmark, Sweden and Belgium.

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I should especially welcome material from the South of England, where, I am convinced, many new forms await discovery.

Genus **Frankliniella**, Karny (*Physapus*, Serv.).

Frankliniella breviceps, sp. nov.

Length about 1.0 mm. Dark chestnut-brown, head yellowish-brown, fore femora greyish-yellow, lighter apically, fore tibiae yellow, lightly tinged with grey; hind and intermediate femora light greyish-brown, yellowish at extreme tips, tibiae greyish-brown, yellowish apically and at knees; all tarsi yellowish.

Head short, only slightly more than three-fifths the length of prothorax and two-fifths as long as broad. Prothorax one half as long as broad; anterior-marginal spines almost as long as those at posterior angles. Pterothorax broader than, and two and one-half times as long as the prothorax. Wings long, over-reaching the tip of the abdomen; white, lightly tinged with grey; spines long and strong, black; lower cilia of fore-wings wavy.

Abdomen ovate, a little broader than the pterothorax; tip sharply narrowed and furnished with long and rather slender bristles, which are nearly one and one-half times as long as the length of the prothorax.

Hab.—One female taken by Mr. C. O. Waterhouse at Acton, August 22nd, 1906.

The antennae are unfortunately broken in the type specimen, but it may be readily separated from *vulgatissimus* (Hal.), *lenuicornis* (Uzel), and *pallidus* (Uzel), by the form of the head, which is not contracted behind. *Breviceps* comes in the group containing *robustus* (Uzel), *nervosus* (Uzel), and *nigriventris* (Uzel), and differs from each of these species by the shortness of its head; from *robustus* by the type of coloration, smaller size, the light-coloured wings and apparent absence of the fore-tarsal tooth; from *nervosus* by the much shorter head and coloration, and from the macropterous form of *nigriventris* by the dark colour of the thorax, the long strong wings and the colour of the hind and intermediate tibiae.

Genus **Euthrips**, Targ.-Tozz.

Euthrips pallipennis, Uzel.

Uzel. Monographie der Ordnung Thysanoptera, 1895, p. 110, pl. v, fig. 57.

This species is recognised from its allies by the form of the antenna which has the third joint considerably longer than the

second, the third and fourth long and spindle-formed, and the sixth shorter than the third. The wings are light, from which feature the species gets its name.

I have a specimen taken in the flower of the field scabious (*Scabiosa arvensis*) at Hart, Co. Durham, July, 1907.

Distribution.—Bohemia, Heligoland, Sweden and Finland, England.

Genus *Amblythrips*, nov.

Near *Euthrips*. Ocelli and wings absent, head shorter than prothorax, antennae about twice as long as the head with the style two-jointed and less than one-half as long as the sixth joint; maxillary palpi three-segmented. Prothorax slightly and evenly narrowed anteriorly with two long bristles at each posterior margin.

Last abdominal segment in the female broadly rounded and ovipositor rather short, apparently almost straight laterally and protruding slightly beyond the end of the abdomen; bristles on the two apical segments long, all others short.

Type *Amblythrips ericae*, mihi.

In 1907 Mr. H. Karny, in his paper "Die Orthoperenfauna des Kustengebietes von Österreich-Ungarn" suggested dividing the genus *Physopus* or *Euthrips* into five genera, representing five of the main divisions, tabulated by Uzel, namely *Physapus*,¹ Serv. (type *vulgatissimus* (Hal.)); *Odontothrips*, Serv. (type *O. phalerata* (Hal.)); *Taeniothrips*, Serv. (type *T. primulae* (Hal.)); *Euthrips*, Targ.-Tozz. (type *E. ulmifoliorum* (Hal.)); and *Pezothrips*, Karny (type *P. frontalis* (Uzel)). This arrangement is a very helpful one and I believe perfectly sound, as the characters relating to the chaetotaxy are apparently considerably more valuable than has hitherto been acknowledged. The genus *Pezothrips*, Karny, contains the two species *frontalis* (Uzel) and *pilosus* (Uzel), and a new form in my possession from Norway, whilst recently Karny describes *Pezothrips* (?) *pedestris*, which it will be seen he doubtfully refers to that genus.

This latter species apparently belongs to the genus above diagnosed, which would appear to be a well-defined one, differing from *Pezothrips* by the entire absence of ocelli and wings, the shorter antennal style, the form of prothorax and the rounded tip of abdomen, this latter character suggesting the generic name.

¹ *Frankliniella*, Karny.

Amblythrips ericae, sp. nov.

Female, length 0.6 mm.

Colour reddish-yellow, prothorax very slightly, margins of abdomen and head (more noticeably distally) greyish-brown; two basal joints of the antennae yellow and the others dark grey, with a slight brownish tinge; all legs light yellow.

Head broader than long, widening posteriorly, with mouth-cone reaching across the prosternum. Antennae separated at base, first joint broader than long, cylindrical; second broadly cyathiform, broad; third faintly claviform; fourth oviform, as wide as third, but slightly longer; fifth constricted at base and truncate at apex, narrower than the eighth and preceding joints. Relative lengths of joints, 5, 9.5, 9, 11, 8, 12.5, 2, 3.5.

Prothorax transverse, not quite three-fifths as long as broad across hind angles, where it is widest; narrowed evenly from base to fore-margin; two long bristles at each posterior angle. Pterothorax slightly broader than prothorax, transverse. Legs rather stout, spine at tip of hind tibia within.

Abdomen rather long and sub-linear, only a little broader than the pterothorax.¹ Bristles moderately long, those on ninth segment exceptionally long, about half as long again as those on the tenth segment and more slender. Tenth segment broader than long, and broadly rounded.

Hab.—Five specimens on heather (*Calluna*) in an old fir plantation at the edge of the moors near Ravenscar, Yorkshire, at about 800 feet. There is also a single example in my tube of *Oxythrips parviceps* and *Euthrips ericae* taken at Colntraive in the Kyles of Bute, July, 1907.

A. pedestris (Karny) differs from *ericae* by the form, relative lengths and coloration of the antennae, and by the extremely long prothorax, the mouth-cone in that form only reaching about half-way across the prosternum.

Genus **Oxythrips**, Uzel.

The following table of the known species may be useful. *O. firmus* has not yet occurred in this country, but is apparently not uncommon in Bohemia.

I. Colour generally yellowish. Hind angles of prothorax with a single bristle. Prothorax slightly longer than head:

¹In one specimen the abdomen is shrunken and apparently oviform and broader than in the others.

- (a) Tenth abdominal segment in the female very long, almost tubular. The upper vein of the fore-wing set with five bristles in the apical half. (Habitat usually in flowers of pine trees). . . . *brevistylis* (Trybom).
 - (b) Tenth abdominal segment normally long. The upper vein of the fore-wing set with three bristles in the apical half. End of fore-tarsus with a small needle-like bristle. (Habitat usually in flowers of *Muga reptans*). . . . *ajugae*, Uzel.
- II. Colour generally darker. Hind angles of prothorax each with two bristles. Prothorax considerably longer than the head:
- (a) Head longer and slightly widened posteriorly:
 - (i.) Body wholly black or blackish-brown; end of second and the whole of third antennal joint yellowish, fourth greyish-yellow. Prothorax longer and less strongly transverse. (Habitat usually on grass). . . . *firmus*, Uzel.
 - (ii.) Colour lighter, abdomen yellowish-brown and black at apex; antennal joints three to eight uniform dark grey or greyish-black. Prothorax shorter in comparison to length of head, and strongly transverse. (Habitat apparently in sphagnum). . . . *brevicollis*, Bagnall.
 - (b) Head very small and slightly narrowed or contracted posteriorly. Resembling *brevicollis* in general form and coloration, but having the head narrower, shorter, and contracted posteriorly, and the prothorax narrower and longer and roundly narrowed anteriorly. (Habitat usually in flowers of *Calluna* and *Erica*). . . . *parviceps*, Uzel.

Oxythrips brevistylis (Trybom).

Belothrips bicolor. Reuter, Öfv. Finsk. Vetensk.-Soc. Förh., 1878-9, xxi.

Belothrips brevistylis Trybom, Ent. Tidskr., 1895, xv, p. 185.

Oxythrips hastata, Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 135, pl. v, fig. 66.

By beating the flowers of pine; in numbers, Prestwich Carr, Northumberland, June, 1910; in a wood above Westgate in Wear-dale, Co. Durham, June, 1910; and between Riding Mill and Minsteracres, and on the road from Minsteracres to Slaley, and Slaley to Hexham, Northumberland, July, 1910.

Oxythrips brevicollis, sp. nov.

Closely resembling *O. parviceps* in size and structure, differing chiefly in the type of coloration and in the form of the prothorax, which is strongly transverse, two and one-third times as broad as long, and has the lateral margins only very slightly converging anteriorly.

The head, which widens posteriorly, with the prothorax is dark grey-brown in colour, whilst the pterothorax is more of a yellowish-brown tinged with grey. The abdomen is yellow, or light yellowish-brown shaded with grey, from the fifth segment to the tip of the eighth being almost entirely grey, and the ninth and tenth uniform grey-black. Antennae uniform dark grey or grey-black, with the two basal joints lighter and tinged with brown. All femora greyish-yellow and tibia lighter and shaded to a light yellow at tips; all tarsi yellow. Wings light grey.

Head basally and fore-margin of prothorax distinctly broader than in *parviceps*, prothorax broader and shorter, with the sides only slightly narrowing towards head; spines on hind-tibia excepting the distal pair comparatively shorter and the abdominal bristles, especially the lateral and sublateral pairs from the third to the eighth segment comparatively longer.

Hab.—One female taken in sphagnum on the moors near Ravenscar, Yorkshire, at about 700 feet, September, 1910. Owing to the stormy weather I was unable to search for further material.

Genus **Thrips**, L.**Thrips validus**, Uzel.

Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 183.

A single male taken in the flower of a dandelion at Gibside in June, 1907, is referable to this species. *T. validus* belongs to the group wherein the species have fifth antennal joint decidedly shorter than the fourth, and is separated from the allied form *linaria*, Uzel, by its larger size and in having the third and fourth and the basal part of the fifth joints light in colour.

Distribution.—Bohemia (Uzel), England.

Thrips albopilosus, Uzel.

Uzel, Monographie der Ordnung Thysanoptera, 1895, p. 190.

A female and two males taken on juniper with *T. juniperina* at Nethy Bridge, Inverness-shire, July, 1908, differs from *T. flavus* var. *obsoletus* in having the fifth antennal joint almost if not quite

as long as the fourth, the fifth and sixth segments broadly united, and the style comparatively longer. The female specimen agrees well with Uzel's description of *albopilosus*, but before describing the male or writing further on this species, I shall make every endeavour to obtain more material.

Distribution.—*T. albopilosus* has only been recorded from Bohemia (Uzel), and the male is not described.

Genus **Bagnallia**, Karny.

Bagnallia agnessae, sp.n.

Forma macroptera.

Female: length 1.45 mm.

Dark blackish-brown, pterothorax slightly lighter; second and fourth antennal joints brownish and the third clear yellow; all tibiae shaded to yellowish and all tarsi yellow-brown apically; fore-wings greyish-brown, darkest at tips, light patch at base, lower wings white, greyish towards tip.

Head practically as long as broad, and about seven-eighths the length of the prothorax; frons rounded between eyes. Eyes not quite so prominent as in *klapaleki*, but distinctly bulging, coarsely faceted; ocelli rather widely separated and the anterior ocellus smaller than the others.

Cheeks slightly constricted behind eyes and thence parallel to base, surface towards base mildly striate. Mouth-cone reaching across prosternum. Antennae one and four-fifths as long as the head, inserted below vertex with the joints sub-contiguous. First joint short and broad, second only slightly constricted at base and truncate at apex; third and fourth narrower than the preceding or succeeding joints (style excepted), each mildly constricted at base and faintly narrowed distally (the third with a short distinct stem), truncate at apex; fifth broader, widened roundly from base, apex truncate and broadly jointed to base of sixth which, including style, is narrowed evenly from basal third to extreme tip. Relative lengths of joints excluding stem of the third joint: 7, 14, 15, 14, 13, 17, 8.

Prothorax transverse, two-thirds or a little more than two-thirds as long as wide across basal third; sides evenly and gently narrowed anteriorly, hind margin arcuate, hind-angles broadly rounded; fore-margin and angles obtuse. Two long bristles at each hind angle; other marginal bristles short, a lateral bristle below the mid-line being a little longer than any of the others.

Pterothorax broader than the prothorax and longer than broad. Legs rather stout, especially the anterior pair, hind tibiae armed with a series of short spines from the middle to the tip within. Wings short, reaching to the hind-margin of the fifth abdominal segment.

Fore-wing broadest at base, apparently narrowed slightly near middle and pointed at tip; only seventeen to twenty spines along the fore-margin, which are long and widely spaced, and one or two spines at tip; veins obsolete, fore-vein with two spines distally, one near middle and three basally; hind vein with as a rule seven unevenly spaced spines; hind cilia long. Hind-wing narrower than fore-wing, pointed at tip; median vein running for almost the length of wing; hairs on fore-margin few and widely spaced, cilia on hind-margin long.

Abdomen elongate-ovate; wider than pterothorax, widened to fourth segment, and very sharply narrower from fore-margin of seventh segment to tip; tenth segment four-fifths as long as the ninth. Bristles on ninth and tenth segments long, longer than the segments bearing them; a short curved lateral bristle on eighth segment; other lateral bristles shorter and not so noticeable.

Hab. Several females on grass by the side of a ditch, Gibside, Co. Durham, October, 1910.

Allied to *klapaleki* (Uzel), *calcarata* (Uzel), *discolor* (Hal.), *angusticeps* (Uzel), *viminalis* (Uzel), *longicollis* (Uzel), *palustris* (Reut.) and *capito*, Karny.

Separated readily from *calcarata* by absence of fore-tarsal tooth and colour; from *klapaleki*, *palustris* and *angusticeps* by the shape and relative lengths of antennal joints; from *longicollis* and *viminalis* by the colour of the antennae and from *discolor* and *capito* by the shape of head and colour. So far as I can gather *agnessae* differs from all the above-named species with the exception of *calcarata* and *klapaleki*, in having the eyes distinctly bulging or laterally prominent, and as it is readily separated from these forms I have little hesitation in naming it as new.

***Bagnallia halidayi*, sp. nov.**

Forma brachyptera.

Male: length, 0.85 mm.

Colour, dark blackish-brown, head and prothorax black, pterothorax lighter; antennal joints two, three and four clear yellow, tinged lightly with grey apically; basal joints brown, and five to

seven grey, with base of fifth light. Fore-tibiae and end of fore-femora yellow, hind and intermediate-tibiae yellow, tinged with grey at knees. Wing-pads white.

Head about as long as broad, and a little longer than the prothorax; like *agnessae*, but with the eyes less prominent. Antennae as in *agnessae*; relative lengths of joints, excluding the short stem of the third segment, as follows: 5, 9.5, 10.5, 11, 10, 13, 6.

Prothorax transverse, seven-eighths as long as the head and one and five-eighths as broad as long; two long bristles at each posterior angle, three-sevenths the length of the prothorax. Pterothorax a little broader than the prothorax and about as long as broad; sides of metathorax gently converging to base of abdomen. Wings reduced to a pad. Fore-legs short and stout; intermediate pair short, but not so stout; hind pair long, spines on the inner side of hind-tibiae with the exception of the apical one, weak.

Abdomen about as broad as the prothorax, gently narrowing apically from the seventh segment. Apex bluntly rounded; eighth segment with moderately long bristles at hind-angles, ninth and tenth with several longer and apparently more slender bristles. Each of the sternites three to seven with a strongly transverse depression, relative lengths across each depression as follows: 15, 17.5, 20, 15, 9. In one specimen the third depression is only the same breadth as the second.

Hab.—Four males from coarse grass growing by the side of a rivulet in Epping Forest, near Chingford, September, 1910.

Easily separated from *agnessae* by colour of antennae and legs, and by the less prominent eyes. Comes nearest *angusticeps*, *viminalis* and *longicollis*. The male of the first two of these species is known; *angusticeps* has an elliptical depression on each of the sternites 3, 5, 6, and 7, and a minute circular depression on the fourth, whilst *viminalis* has a circular depression on each of the sternites three to six. Only the female of *longicollis* is known, from which *halidayi* may be recognized and easily separated by having the fifth antennal joint only very slightly shorter than the fourth, and by the coloration of the antennae. The female of *longicollis* is smaller than the male of *halidayi*.

A PRELIMINARY LIST OF THE THYSANOPTERA KNOWN TO OCCUR IN THE BRITISH ISLES.

ORDER THYSANOPTERA.

Sub-order TEREBRANTIA.

Aeolothripidae, Hal.

AEOLOTHRIPS, Hal.

- † 1. *A. melaleucus*, Hal.
- 2. *A. vittatus*, Hal.
- 3. *A. fasciatus* (L.).
- 4. *A. albocinctus*, Hal.

MELANOTHRIPS, Hal.

- 5. *M. fuscus* (Sulz.).

Thripidae, Hal.

CHIROTHRIPS, Hal.

- 6. *C. manicatus*, Hal.
- * 7. *C. similis*, Bagnall.

LIMOTHRIPS, Hal.

- 8. *L. denticornis*, Hal.
- 9. *L. cereallum*, Hal.

SERICOTHRIPS, Hal.

- 10. *S. staphylinus*, Hal.

FRANKLINIELLA, Karny (Physapus, Serv.).

- 11. *F. vulgatissimus* (Hal.).
- * 12. *F. robustus* (Uzel).
- * 13. *F. breviceps*, Bagnall.

ODONTOTHRIPS, Serv.

- 14. *O. phaleratus* (Hal.).
- 15. *O. ulicis* (Hal.).

EUTHRIPS, Targ.-Tozz.

- † 16. *E. asperus* (Hal.).
- 17. *E. atratus* (Hal.).
- * 18. *E. inconsequens* (Uzel).
- 19. *E. primulae*, (Hal.).
- 20. *E. ericae* (Hal.).
- * 21. *E. pyri*, Dan.
- * 22. *E. pallipennis* (Uzel).
- 23. *E. ulmifoliorum* (Hal.).
- * 24. *E. orchidii*, Moulton.
- * 25. *E. longipennis*, Bagnall.

AMBLYTHRIPS, Bagnall.

- * 26. *A. ericae*, Bagnall.

OXYTHRIPS, Uzel.

- * 27. *O. brevistylis* (Trybom).
- * 28. *O. ajugae*, Uzel.
- * 29. *O. parviceps*, Uzel.
- * 30. *O. brevicollis*, Bagnall.

PACHYTHRIPS, Uzel.

- † 31. *P. subapterus* (Hal.).

ANAPHOTHRIPS, Uzel.

- 32. *A. obscurus* (Mull.).
- * 33. *A. orchidaceus*, Bagnall.

UZELIELLA, Bagnall.

- * 34. *U. lubbocki*, Bagnall.

APTINOTHRIPS, Hal.

- 35. *A. rufus* (Gmel.).
- 36. *A. nitidulus*, Hal.

BELOTHRIPS, Hal.

- † 37. *B. acuminatus*, Hal.

HELIOTHRIPS, Hal.

- 38. *H. haemorrhoidalis* (Bouche).
- * 39. *H. femoralis*, Reut.

PARTHENOTHRIPS, Uzel.

- * 40. *P. dracaenae* (Heeger).

LEUCOTHRIPS, Reut.

- * 41. *L. nigripennis*, Reut.

THRIPS, L.

- 42. *T. physopus*, L.
- * 43. *T. tabaci*, Lind.
- * 44. *T. major*, Uzel.
- * 45. *T. salicarius*, Uzel.
- * 46. *T. validus*, Uzel.
- 47. *T. flavus*, Sch.
- † 48. *T. fuscipennis*, Hal.
- * 49. *T. juniperina* L., Bagnall.
- 50. *T. minutissimus*, L.
- * 51. *T. albopilosus*, Uzel.

BAGNALLIA, Karny.

- † 52. *B. discolor* (Hal.).
- * 53. *B. agnessae*, Bagnall.
- * 54. *B. halidayi*, Bagnall.

BALIOTHRIPS, Uzel.

- † 55. *B. dispar* (Hal.).

* Recorded since the publication of Haliday's papers.

† Species of which I have not yet had the opportunity of examining British examples.

PLATYTHRIPS, Uzel.

56. *P. tunicatus* (Hal.).

Sub-order TUBULIFERA.

Phloeothripidae, Hal.

MEGATHRIPS, Targ.-Tozz.

- *57. *M. lativentris* (Heeger).
 *58. *M. nobilis*, Bagnall.

CRYPTOTHRIPS, Uzel.

- *59. *C. latus*, Uzel.
 *60. *C. dentipes* (Reut.).

ANTHOTHRIPS, Uzel.

61. *A. statoces* (Hal.).
 62. *A. aculeatus* (Fab.).
 63. *A. subtilissimus* (Hal.).

TRICHOTHRIPS, Uzel.

- *64. *T. longisetis*, Bagnall.
 65. *T. pedicularius* (Hal.).
 *66. *T. propinquus*, Bagnall.
 *67. *T. semicaecus*, Uzel.
 68. *T. ulmi* (Fab.).
 69. *T. pini* (Hal.).
 *70. *T. copiosus*, Uzel.

PHLOOTHRIPS, Hal.

71. *P. coriaceus*, Hal.

ACANTHOTHRIPS, Hal.

- *72. *A. nodicornis* (Reut.).

LIOTHRIPS, Uzel.

- *73. *L. hradezensis*, Uzel.
 *74. *L. setinodis* (Reut.).

RAT FLEAS.*

By

A. E. SHIPLEY, F.R.S.

*"In 'x' finita tria sunt animalia dira :
Sunt pulices fortes, cimices, culicumque cohortes ;
Sed pulices saltu fugiunt, culicesque volatu
Et cimices pravi nequeunt foetore necari."*

It used to be the custom to classify the fleas with the *Diptera*, but in recent years there has been an increasing tendency to split into smaller groups the larger Orders of Insects which satisfied our forefathers, and fleas have now been promoted to the rank of an Order of Insects under the name of the *Siphonaptera*, a term proposed

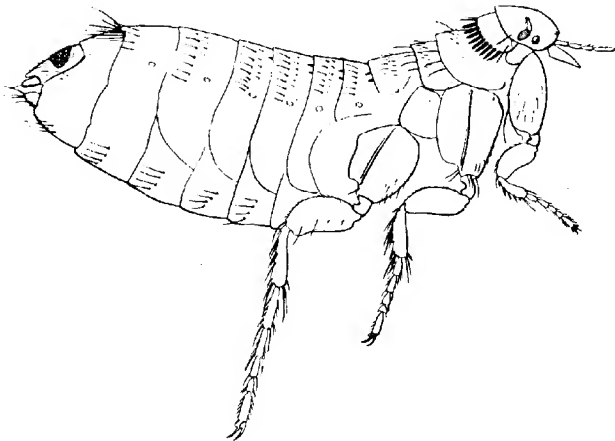


Fig. 1.—*Ceratophyllus fasciatus* (female). Magnified thirty times.

by Latreille some years before Kirby suggested the name *Aphaniptera*.

The head of a flea is small, and the antennæ are short and in rather an unusual position, sunk in a groove and of three joints only, the terminal one being very sensory (Figs. 1 and 2). The mandibles

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take the form of long styles with saw-like edges (Fig. 3). The organ with which the insect injects the secretion which sets up the irritation in the bitten is conveyed by a median unpaired hypopharynx.

The first maxillæ have long palps, or sensory organs, which project forward and look like and appear to act as antennæ. The labial or second maxillary palps are also very large, and form a sheath in which the biting styles play (Fig. 3).

The male flea is generally not more than half the size of the female, and the dorsal surface of its abdomen is concave (Fig. 2). In both sexes the three thoracic segments are distinct, and the anterior legs have an extra articulation which throws them forward and gives them almost the appearance of arising from the head (Fig. 2). The legs are unusually powerful, and well adapted for leaping, especially the third pair. So great are their powers of jumping that could a

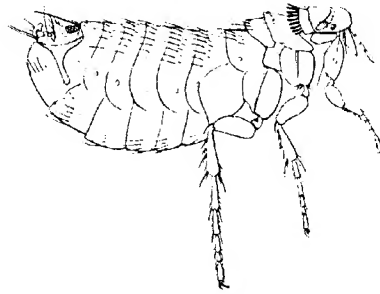


Fig. 2.—*Ceratophyllus fasciatus* (male). Magnified thirty times.

flea be enlarged to the size of a lion without loss of strength, it could spring two-thirds of a mile. The abdomen has nine segments, and the structures at the posterior end are used for the purposes of separating the species.

Fleas undergo a very complete metamorphosis. The eggs are laid some twelve at a time among the hair of the host, or in crannies or cracks in wainscoting, among dirty linen or in crevices in the floor (Fig. 4). They are oval, white, porcelain-like, beautiful ova, not affixed to the hair of their host, for they readily fall on to the ground, and are commonly found where the host sleeps, in kennels and in lairs. The young larva when it emerges is seen to be provided with a process on the head for breaking the egg-shell.

The larva itself is small (Fig. 5), with the mouth-parts of a mandibulate insect. It is provided with a head and thirteen seg-

ments, very uniform in appearance, and is, as a rule, of a whitish colour. In spite of having no legs, these little creatures are very active and move quickly about, aided by the wriggling of the body and by numerous bristles. The larvæ live upon any organic refuse found in the dust of the place where they are born and they can be reared upon the sweepings of living-rooms. After a varying number of days, and after casting their skin once, twice or thrice, they pass into the pupa stage, in which the limbs are free. The larva when changing into the pupa spins for itself a little white silken cocoon (Fig. 6), which is frequently covered with dust. After a time the pupa (Fig. 7), which is white, becomes gradually darker, and in a week or two the imago, or perfect insect, emerges. The whole metamorphosis does not last long; the entire development of the generation of a cat flea occupies but little more than a fortnight.

Eight or nine years ago Mr. L. O. Howard, Government Entomologist at Washington, made a series of experiments with *Pulex serraticeps*, a common dog or cat flea. He collected a number of eggs and placed them in two glass vessels; one was kept dry and the other moist with damp blotting-paper. The eggs hatched out as a rule in about twenty-four hours after having been placed in position, and the young larvæ soon showed a brown tinge to their alimentary canal, indicating that they had been feeding on some dried blood which had been given them for food. The larvæ were very active, crawling about, wriggling their bodies and moving their heads and their numerous bristles. They were difficult to rear, an excess of moisture or too much dryness being equally fatal. They cast their first skin in from two to seven days after hatching, and they cast a second skin two or three days later. The length of the larval life varied considerably, from a week to fourteen days, probably being dependent partly on the food supplied and partly on external conditions. The larvæ vary also in the number of skins they cast before they curl themselves up and begin to spin their cocoon, some apparently having cast three skins, others only one. The cocoon is a flattened structure, adherent to some surface, on the lower side, but it soon becomes inconspicuous from the dust which collects and adheres to it. If disturbed while building the cocoon the larva leaves the incomplete structure and transforms into the pupa outside it. On an average the larvæ commence spinning between the seventh and fourteenth day after hatching from the egg, and the imago emerges five days later. It thus appears that in summer-time, at Washington, the whole metamorphosis, from egg to imago, takes from a fortnight to three weeks. This confirms

some similar observations made by Mr. W. J. Simmons in Calcutta.

It is not difficult to destroy fleas in the larval stage. They are delicate organisms, and do not develop well in situations where they are likely to be disturbed; but if undisturbed they flourish in the sweepings of floors or where dust collects in the crevices and cracks between boards. This accounts for the great accumulation of fleas that sometimes takes place in unoccupied houses during the summer months.



Fig. 3.—Mandibles of a flea. Highly magnified. From Wagner.

1.—Mandibles. 2.—First Maxilla. 3.—Palp of first Maxilla. 4.—Second Maxilla.
5.—Hypopharynx.

The destruction of the adult flea is a much more difficult problem. Various powders and the using of the Californian Buhach and Pyrethrum have at times been unsuccessfully tried, and even a free sprinkling with benzine of the place where dirt had collected was ineffective in one case of extreme infection. One method of getting rid of fleas was successfully practised by Professor Gage of Cornell University. He draped the legs of the "janitor" of the building with fly-papers, with the sticky side outwards. The

"janitor" then proceeded to walk up and down the floor of the infected room, with the result that nearly all the fleas jumping at his ankles, as they always do, were caught on the fly-papers.

Fleas are sometimes found in uninhabited rooms in numbers which seem incredible. The floor seems covered with a dense, moving haze of minute insects leaping in the air. These hungering fleas will readily attack any unhappy person or animal that enters the room. Although certain species of flea are usually associated with but one host, many species pass readily from one animal to another. Rabbit fleas will pass on to cats, and fleas from many mammals undoubtedly do bite man. One of the largest, of the one hundred and fifty odd species of fleas, is the *Hystrichopsylla talpæ*,



Fig. 4.—Egg of a flea. Very highly magnified. From Howard.

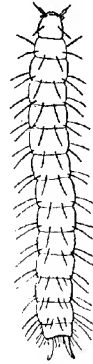


Fig. 5.—Larva of a flea. Magnified ten times. After Laboulbène.

which occurs on moles, voles and field-mice. It is also found in the nests of the humble bee, *Bombus subterraneus*, where it is probably carried by the voles which burrow into their nests. *Pulex serraticeps*, a common dog flea already mentioned, apparently acts as the intermediate host of one of the *Tænia*s which infest the alimentary canal of the dog.

The following list of fleas found on *M. decumanus* and *M. rattus* and their allies is compiled from the Hon. N. Charles Rothschild's Synopsis (Bulletin of Entomological Research, Vol. I, 1910, page 89). In this valuable paper he has enlarged and corrected the list which he kindly helped me to draw up, as a part of my paper on the Parasites of the Rat (Journal of Economic Biology, Vol. III, 1908, page 61) some two years ago.

FAMILY I.—SARCOPSYLLIDÆ.

This family is that of the Chigoes or Jiggers, whose females burrow in the skin of the feet of man in South America.

I. Genus *DERMATOPHILUS*, Guér.

1. *D. caecata*, Enderl.—Male unknown; this species has been taken in Brazil on and behind the ears of *M. rattus*.

II. Genus *ECHIDNOPHAGA*, Olliv. The genus belongs to warm countries in the Eastern Hemisphere. Numerous species are known, four of which have been found on rats.

2. *E. gallinaceus*, Westw. A common species, particularly on the heads of fowls in tropical Asia and Africa; introduced into the United States; also found on rats in Africa.



Fig. 6.—Larva of a flea. Spinning silk cocoon. Magnified about ten times. After Howard.

3. *E. myrmecobii*, Rothsch. A species peculiar to Australia, where it has been taken on several indigenous animals and also on rats.

4. *E. murina*, Tirab. A native of Southern and South-Eastern Europe, where it occurs on the heads of rats; it is apparently rare.

5. *E. liopus*, Rothsch. Found on rats in India; originally described from Western Australia, where it is plentiful on *Echidna*.

FAMILY II.—PULICIDÆ (TRUE FLEAS).

III. Genus *PULEX*, L.

6. *Pulex irritans*, Linn. The human flea; practically cosmopolitan. It has been found on *M. rattus* and *M. decumanus* and many other animals which come in contact with man.

IV. Genus *XENOPSYLLA*, Glink.—This genus includes numerous species from Africa: one of them *X. cheopis*, Rothsch., is now practically cosmopolitan, and another, *X. brasiliensis*, Baker, has been introduced into South America.

7. *X. cheopis*, Rothsch.—Originally discovered in Egypt; this is the common flea of rats in the tropics. Although apparently cosmopolitan, it does not flourish in temperate and cold climates. It is the chief agent in conveying plague from rats to man in the East.

This flea was described by Rothchild from specimens taken from numerous small rodents in Egypt. Tiraboschi found it commonly in Italy, and in forty per cent. of the ship rats in Genoa. It occurs on from eighty per cent. to ninety per cent. of the rat population of Sydney and Brisbane, where it was



Fig. 7.—Pupa of a flea. Magnified ten times. After Howard.

described by Tidswell under the name of *Pulex pallidus*, and on twenty-five per cent. of the rats in Marseilles, where Gauthier and Raybaud record that the numbers decrease as the distance from the water-front increases. Herzog took forty-two fleas of this species from one hundred and fifty-three rats of both species in Manila, and it also occurs commonly in South America. It has been found at Plymouth and at Pretoria. It is by far the commonest of the rat fleas of warmer countries, and the Plague Commission consider that it forms ninety-nine per cent. of the fleas found on *M. rattus* and *M. decumanus* in India.

8. *X. brasiliensis*, Baker (= *zigetus*, Rothsch.).—This species occurs on rats in West Africa, and has been introduced into Brazil.

V. Genus *HOPLOPSYLLUS*, Baker.—These are North American fleas; one species has been found on rats, but only once.

9. *H. anomalus*, Baker.—This species is recorded from Colorado and California.

VI. Genus *CTENOCEPHALUS*, Kolen.—There are two species, which, although confounded by many authors, are easily distinguished by the shape of the head.

10. *Cl. canis*, Dugès.—This is the flea commonly found on the dog, but it also occurs on rats. It is practically cosmopolitan, but more abundant in temperate countries than in the tropics.

11. *Cl. felis*, Bouché.—This again is a widely distributed and very common flea all over the world on rats as well as many other animals.

VII.—Genus *CERATOPHYLLUS*, Curtis.—The number of species is very large; many of them are found on birds, but five only have been recorded from rats or house-mice.

12. *C. fasciatus*, Bose.—This is the flea most commonly found on *M. rattus* and on *M. decumanus* in Great Britain, and, indeed, throughout Central and Northern Europe. It also occurs on the house-mouse, *M. musculus*. Rats from Cape Town also harbour this species, and it is occasionally found on rats from India. Should the epizootic in Suffolk become an epidemic, this flea will be in all probability the intermediary between rat and man.

13. *C. londiniensis*, Rothschild.—This species is widely distributed on both the British species of rat and of mice. It is apparently rare in England, but a large number of specimens were once taken in South Kensington. Apparently this species does not bite man.

14. *C. anisus*, Rothschild.—Originally described from Japan, where a male was obtained off *Felis* sp. Another specimen was found at San Francisco, California, taken off *M. decumanus*.

15. *C. penicilliger*, Grube.—This flea, like *Ctenophthalmus agyrtus*, is common on the field-mouse (*M. sylvaticus*) in England, and occurs on rats and small Carnivora in Europe and North Asia. One specimen was taken off *M. decumanus* at Rannoch, Scotland.

16. *C. niger*, Fox.—A bird-flea from California, but also occurring on rats.

VIII. Genus *PYGLOPSYLLA*, Rothsch.—A number of species are known from the tropical countries of the Eastern Hemisphere, two being recorded from rats. Specimens of both these fleas have been sent from Australia labelled "from *M. rattus*"; but subsequent examinations of large numbers of this animal in the same locality have not yielded any more. As both fleas are common on *M. assimilis*, a purely Australian rat, it is probable that the hosts called *M. rattus* were really *M. assimilis*.

17. *P. hilli*, Rothsch.

18. *P. rainbowi*, Rothsch.

IX. Genus *CHLSTOPSYLLA*, Rothsch.—The genus includes a few species from South Africa, one of which has been obtained from a rat.

19. *Ch. rossi*, Waterst.—Only one female known, which was taken off a rat in South Africa. Probably a common flea.

X. Genus *NEOPSYLLA*, Wagn.—A small number of Palearctic species, one of which was obtained from a rat.

20. *N. bidentatiformis*, Wagn.—Russia.

XI. Genus *CTENOPHTHALMUS*, Kolen.—There are many species of this genus; two species have been recorded from rats.

21. *Cl. agyres*, Heller.—This is a European species, common in England on field-mice and bank-voles, and occurs also on *M. decumanus* when captured in the open.

22. *Cl. assimilis*, Tasch.—This species is found in Central Europe on field-mice; it is common in Germany on *Arvicola arvalis*, and has also been recorded from rats; it is apparently not found in England.

XII. Genus *CTENOPSYLLA*, Kolen.—One of the species has been obtained from rats.

23. *Cl. musculi*, Dugès.—This is a widely distributed species, very common on rats and mice, especially on *M. musculus*, with which it has spread.

XIII. Genus *HYSTRICHOPSYLLA*, Tasch.—One species has been found on rats.

24. *H. tripectinata*, Tirab.—This is a Mediterranean species which occurs on mice and rats. It has also been found in the Azores.

REVIEWS.

Doane, R. W.—Insects and Disease. Pp. xiv + 227, 112 figs. London: Constable and Co., Ltd., 1910. Price 8s. net.

The sub-title of this work explains that it is a popular account of the way in which insects may spread or cause some of our common diseases. The author has attempted to bring together in a non-technical form the more important facts connected with his subject. In spite of a number of minor errors, he has succeeded in presenting a very interesting and readable book, which we commend to the notice of the general public.

The illustrations, of which there are a large number, are good, and there is a useful bibliography for those who desire to extend their reading in more technical channels.

Marshall, Francis H. A. The Physiology of Reproduction. With Preface by E. A. Schäfer, and contributions by William Cramer and James Lockhead. Pp. xvii + 700, 154 figs. London: Longmans, Green and Co., 1910. Price 21s. net.

Dr. Marshall has written a remarkable work, which cannot fail to command the attention of many classes of investigators. As Dr. Schäfer remarks, in a short preface, it is the first time that the physiology of the organs of reproduction has been presented in a complete form. Incidentally the work furnishes a much needed introduction to the science of Eugenics, whilst the multiplicity of facts which are set forth, and the manner in which questions of difficulty are discussed, will not only satisfy but also stimulate inquiry in a most important branch of physiology.

It seems strange that hitherto we have had no comprehensive work dealing with this subject, one of paramount importance to the gynaecologist, physiologist, veterinarian, and breeder of live-stock.

No side of the subject has been left unnoticed, and special mention must be made of the chapters dealing with foetal nutrition, fertility, the factors which determine sex, and that on the biochemistry of the sexual organs.

The work is well illustrated and reflects the greatest credit on the author, all who have rendered him assistance, and the publishers.

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